Remarks

The wording of claims 6 and 7 has been clarified since the wording of claim 6 especially was not believed to be very clear. No new issue arises.

It is respectfully requested that the Examiner reconsider his rejections for the following reasons:

1. The Examiner has failed to show that the cited prior art teaches all the claim limitations.

In order to establish a *prima facie* case of obviousness under 35 USC 103(a),

> "there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach all the claim limitations". See MPEP 2143. (emphasis added)

The prior art, either alone or in combination, does not teach the use of self-assembled quantum dots, a feature of amended claim 1. The Examiner's rejection of claim 1 is based on a combination of Cook and Osinski, with Osinski being cited to show quantum dots. The Examiner appears to have ignored the limitation that the quantum dots are self-assembled, apparently for the same reason as he ignored the limitation in claim 5, namely because he considers this limitation a process limitation. In the applicant's respectful submission, such a position is improper for reasons that will be explained.

Quantum dot structures can be made lithographically with electron beams and etching. Such dots generally have uniform sizes. Another more recent way to make quantum dots is to use three dimensional islanding growth under the Stranski-Krastanov mode. Here the quantum dot material tends to ball up into tiny islands. This effect is the microscopic analog of water forming beads on a clean piece of glass. Such "self-assembled" quantum dots have characteristics such as size distribution that distinguish them from quantum dots formed, for example, by lithographic techniques.

"Self-assembled" quantum dots are recognizable *per se* through their appearance and properties by persons skilled in the art. The reference to self-assembled quantum dots therefore constitutes a valid structural limitation. A mechanical analogy might be, a claim including a "molded component". One can generally distinguish a molded component from one made by other means, and under such circumstances the modifier *molded* constitutes a valid distinction over the prior art if the prior art only show parts that are clearly not molded. Examiner should therefore give patentable weight to the expression "self-assembled" quantum dots. The significance of the expression will be explained further below.

The second reason why the Examiner should give patentable weight to the expression self-assembled quantum dots is that the caselaw makes it clear that even if such a limitation were considered only a process limitation, which is denied, such a limitation can be given patentable consideration. In particular, in *In re Luck*, 177 USPQ 523, the claim recited:

> "A hollow light-transmitting lamp-bulb-shaped glass member adapted to surround a source of radiations, a coating carried on the external surface of said glass member ...
>
> (d) said coating having been affixed to said glass member by applying thereon a liquid organic solvent having dissolved therein said polymer, said organofunctional silane and said additive organic substance, and said coated glass member thereafter being baked."

The Examiner did not regard as significant the process limitation stated in part (d). The CCPA held that the Examiner erred in not attaching significance to the process limitation. The CCPA stated the following:

> "As for the method of application, it is well established that product claims may include process steps to wholly or partially define the claimed product... To the extent these process limitations distinguish the *product* over the prior art, they must be given the same consideration as traditional product characteristics. In the present case, we cannot agree with the Patent Office that the absence of the carrier

in the final product renders the carrier immaterial. The method of application could well result in a difference in the coated article..."

In the presence case, the method of formation of the quantum dots results in a difference in the finished product, namely "self-assembled" quantum dots that have characteristics different from quantum dots formed by other means.

The significance of this limitation is that the applicants have discovered that inhomogeneous broadening occurs during self-assembled growth (see page 11, line 5), as a result of which the emission an gain spectrum can cover a wavelength range hundreds of nanometers wide, making self-assembled quantum dots very useful in a tunable laser, where the external cavity is used to select the wavelength of interest to be amplified. This fact was not known in the prior art and is one foundation of the present invention.

Osinski is silent as to the use of self-assembled quantum dots. Osinski mentions strained structures, but this merely implies a lattice mismatch between the different layers, not necessarily that the quantum dots are self-assembled. There is no teaching in the cited prior art of self-assembled quantum dots as recited by claim 1.

2. The combination of Cook and Osinski is improper for lack of proper motivation.

As stated in *Lindemann Maschinenfabrik GmbH v. America Hoist & Derrick* Co., 221 USPQ 488, in considering obviousness:

> "The critical enquiry is whether "there is something in the prior art as a whole to suggest the desirability, and thus the obviousness, of making the combination." (emphasis added)

Cook and Osinski represent diverse technologies. Cook describes an anti-reflection coating for an optical component such as an external cavity tunable laser. Cook is only concerned with wavelength tuning range and the like. In such a laser, a broad gain spectrum is desirable since stimulated emission must take place over the entire wavelength range covered by the laser. Cook does not describe a broad area laser, nor does Cook suggest that it would be desirable achieve a "high efficiency, broad area semiconductor laser with diffraction limited divergence of the output laser beam." Cook

talks about achieving a "broader spectral gain bandwidth" (col. 4, line 55). This requirement is not to be confused with the desirability in Osinki to achieve a broad area laser. This is a purely spatial effect quite distinct from broad spectral bandwidth.

Osinski by contrast does not describe an external cavity tunable laser. Osinski describes an internal cavity laser that is designed as a broad area semiconductor laser. The expression "broad area" in Osinski of course refers to the spatial extent, not the wavelength range. Given that there is no teaching in Cook that a broad spatial area would be desirable in his laser, there is no reason for a person skilled in the art to incorporate the teachings of Osinski without impermissibly relying on the teachings of the applicant. The courts have repeated time and time again that the motivation for the combination must be found in the prior art as a whole. Moreover, in a fixed wavelength laser there is no need for a broad gain spectrum.

Unfortunately, Examiners, aware of the need to show motivation, often merely identify the object of the secondary reference and give this as a reason to combine the secondary reference with the primary reference without any showing that the primary reference suggests such an object would be desirable in the context of the primary reference. It is respectfully submitted that such a simplistic approach is inconsistent with the caselaw. While it is true that an Examiner can under some limited circumstances artificially combine references giving a motivation that is different from the motivation giving rise to the invention, the alleged motivation must always be found in the prior art as a whole. If the secondary reference teaches a certain structure to achieve a specific effect unrelated to the invention, at the very least the Examiner must show that the primary reference teaches that it would be desirable to achieve this effect in the context of the primary reference. Absent such a teaching in the primary reference, it cannot be said that the motivation to combine the references is found in the prior art. Cook does not described a broad area laser, and says nothing about the desirability of broad area emission in the context of a tunable laser. Why then, other than by using hindsight, would one skilled in the art be motivated to combine the teachings of Osinski with Cook? The Examiner's answer "for the purpose of obtain a high efficiency broad area laser" is not valid when one considers that nowhere does Cook suggest that his laser should be a broad area laser. Cook teaches a

tunable laser, not a broad area laser. It is not sufficient that persons skilled in the art merely *could* have made the combination, there must be an actual suggestion found in the prior art to make such combination.

In *In re Fitch*, 23 USPQ 2d 1780, the Federal Circuit held that:

> "The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification..."
>
> "Here the Examiner relied on hindsight to arrive at the determination of obviousness. It is impressible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the prior art."

The Examiner is right in saying that any consideration of obviousness requires some element of hindsight. However, it is not possible to use the applicant's own teachings, which is the only way of combining Cook with Osinski absent any teaching in cook as to the desirability of achieving a broad area laser and given the disparate teachings (tunable external cavity laser versus broad area internal cavity laser).

A further important point that the Examine appears not to have taken into consideration is that a property of quantum dots is that the allowed electron energies are highly quantized due to the confinement of the electrons (or holes) in three dimensions. They therefore have very precise energy levels, which while potentially useful in a fixed wavelength laser, as taught by Osinski, would intuitively be contrary to the requirements for a tunable laser as taught by Cook. See, for example, Sugiyama, which states that a quantum dot systems "provides a very sharp spectrum when used for an optical semiconductor device". (col. 1, line 34 of Sugiyama). This is directly contrary to what is required in a tunable laser since if the spectrum is sharp, it will only operate at discrete wavelengths. It is only as a result of the applicant's recognition that self-assembled quantum dots, due to their distribution in size, result in inhomogeneous broadening of the energy levels, thereby creating a broad spectrum and making them suitable, contrary to what would be expected from prior art teaching, for use in a tunable laser. This teaching can only be found in the application, not in the prior art. Sugiyama, in his background discussion, recognizes that

spectrum broadening can take place, but he sees this merely as a problem to be overcome, not an effect that can be used to advantage in a tunable laser.

The applicants therefore respectfully submit that absent any suggestion in Cook of the need to make a broad area laser the Examiner has not demonstrated adequate motivation to combine Cook with Osinski. On the contrary, the diverse technologies, tunable laser versus broad area fixed wavelength laser, especially in the light of the teachings in the prior art that the quantum dots result in sharp emission spectra, would teach away from making such a combination given the teaching in Cook that a tunable laser requires a broad gain spectrum so that stimulated emission occurs over a broad range of wavelengths. It is indeed unexpected and contrary to intuition that quantum dots, which are known for their sharp spectra, would be useful in tunable lasers where a broad gain spectrum is required (not to be confused with a broad area laser).

This rejection is therefore respectfully traversed on the grounds that it is improper and the Examiner is respectfully requested to withdraw it.

Claim 5

With regard to the Examiner's refusal to give claim 5 patentable weight, it is respectfully submitted this refusal is improper and inconsistent with the caselaw. The Examiner is referred specifically to *In re Luck, supra,* which makes it clear that process limitations in product claims can be effective at distinguishing over the prior art where the process results in a product having identifiable characteristics, as is the case in claim 5. Quantum dots formed by the process defined in claim 5 have a size distribution that results in broadening of the gain spectrum, thus making them particularly suitable for a tunable laser. They are distinguishable from quantum dots made by other methods and thus under the *In re Luck* the limitation should be given patentable weight.

Claim 6

With regard to claim 6, the Examiner has chosen to combine three references. The Examiner is first reminded of the court's warning against picking and choosing from various references.

Again the Examiner, in need of a motivation, has merely recited the reason for applying a wetting layer in Romano as motivation without regard to whether this would be a valid reason in a combination of Cook and Oskinski (which the applicant's have already submitted is improper in any event). Romano teaches a quantum well structure wherein a wetting layer is placed under the buffer layer to ensure smooth and uniform coverage of the substrate. There is no indication in Cook that smooth and uniform coverage would be desirable. In fact, in the case of the quantum dots in accordance with the invention, smooth and uniform coverage is not desirable because in order to achieve spectral broadening, inhomogeneity is required. This is contrary to the teaching of the reference.

Claim 9

By the time we reach claim 9, the Examiner requires no less than four references to reconstruct the invention. Surely, such an approach is inconsistent with the courts determination that it is impermissible to "pick and choose among references" to reconstruct the invention. The teaching of Sugiyama is directly contrary to the invention since it teaches that quantum dots generally give a sharp spectrum (col. 1, line 34). Sugiyama then goes on to discuss how there are advantages in using Stranski-Krastanov quantum dots, but these have the disadvantage (in Sugiyama's eyes) of having a diffused or spread spectral distribution (see col. 2, lines 33, 34). According to Sugiyama, "It is believed that it is such variation in the size of the quantum dots that causes the foregoing unwanted spreading of the PL peak (emphasis added). Sugiyama then teaches how to avoid this perceived disadvantage. On the contrary the applicants, contrary to Sugiyama's teaching, have appreciated that this "unwanted" broadening can be put to advantage in the context of a tunable laser.

With regard to claims 10 and the remaining claims relating to the specific structure of the laser, the Examiner has rejected the limitations on the parameters either merely as design choice or on the basis of alleged optimization. Such objections only apply to existing products or methods. For example, to quote the MPEP:

> "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (CCPA

1955) (Claimed process which was performed at a temperature between 40°C and 80°C and an acid concentration between 25% and 70% was held to be *prima facie* obvious over a reference process which differed from the claims only in that the reference process was performed at a temperature of 100°C and an acid concentration of 10%.).

The prior art does not teach that high efficiency lasers tunable over a wide range can be constructed in the manner claimed. It is improper merely to reject these claims on the basis that the choice of materials and parameters is design choice or optimization because the prior art does not disclosed high efficiency tunable lasers employing such materials to create tunable lasers.

The Examiner is therefore respectfully requested to reconsider his rejection to the in the light of the above comments. The invention represents an important advance in the art, namely a high efficiency laser tunable over a wide wavelength range, and relies on the use of self-assembled quantum dots, which prima facie, would have characteristics, namely sharp spectrum, ill-suited to tunable lasers, where blurred spectra are required so as to produce a broad gain spectrum.

It is believed that this application is in condition for allowance and reconsideration and allowance are respectfully requested.

Respectfully submitted

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Marked Up Version showing amendments

6(Amended). The laser system of claim 5, further comprising a wetting layer underneath said low dimensional structures arranged such that energy levels in said low dimensional structures lie below a subband in said wetting layer ~~such that one or more low-dimensional levels are confined below a barrier energy with one two-dimensional subband for the said wetting layer confined below the barrier energy but above the levels of the low dimensional structures~~.

7(Amended). The laser system of claim 6, wherein ~~a part or for the wh~~all or a part of the~~ole~~ spectral region comprised between the emission of the said wetting layer and the emission of the lowest energy low-dimensional level is tunable for lasing by selecting a parameter selected from the group consisting of: parameters which control the level of saturation or the optical gain.